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Guaraldi et al.

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(54) **ADJUSTABLE FORM ROLL APPARATUS**

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B41F 7/04	(2006.01)
B41F 7/12	(2006.01)
B41F 13/20	(2006.01)

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CPC . ***B41F 13/02*** (2013.01); ***B41F 7/04*** (2013.01); ***B41F 7/12*** (2013.01); ***B41F 13/20*** (2013.01); ***B41F 31/301*** (2013.01); ***B41F 31/305*** (2013.01); ***B41F 31/307*** (2013.01); ***B41F 31/308*** (2013.01); ***B41F 31/34*** (2013.01); ***B41F 31/36*** (2013.01)

(58) **Field of Classification Search**

CPC B41F 31/301; B41F 31/34; B41F 13/008; B41F 13/44; B41F 7/04; B41F 7/12; B41F 13/02; B41F 13/20; B41F 31/36; B41F 31/305; B41F 31/307; B41F 31/308

USPC 101/217, 485, 216, 247

See application file for complete search history.

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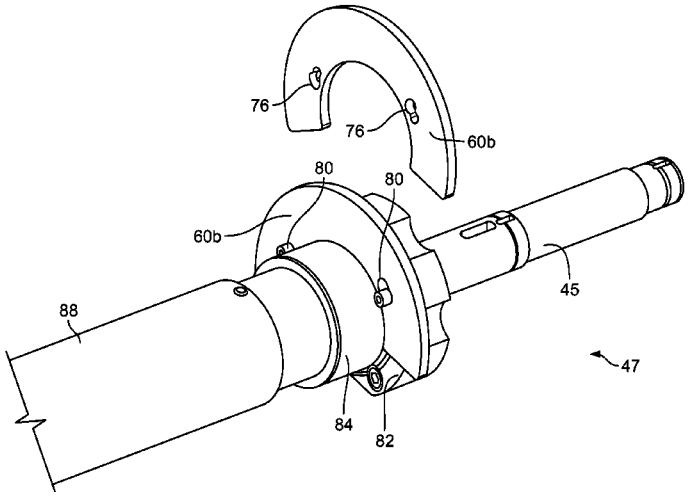
(57) **ABSTRACT**

An apparatus for adjustably positioning a form roll having a form roll axis against at least two different sized plate cylinders in a variable cutoff printing unit is provided. The apparatus includes a plate cylinder support for interchangeably supporting the at least two different sized plate cylinders, the plate cylinder support including a plate cylinder axis at least two different sized plate cylinder cams. The at least two different sized plate cylinder cams are interchangeably removably connectable to the plate cylinder support and include a smaller plate cylinder cam and a larger plate cylinder cam that are removably connectable to the plate cylinder support as alternatives of each other. The apparatus also includes a form roll hanger for supporting the form roll that is configured for contacting the smaller plate cylinder cam if the smaller plate cylinder cam is coupled to the plate cylinder support to set a smaller distance between the plate cylinder axis and the form roll axis. The form roll hanger is also configured for contacting the larger plate cylinder cam if the larger plate cylinder cam is coupled to the plate cylinder support to set a larger distance between the plate cylinder axis and the form roll axis. A method of adjustably positioning a form roll and a variable cutoff printing press are also provided.

12 Claims, 11 Drawing Sheets



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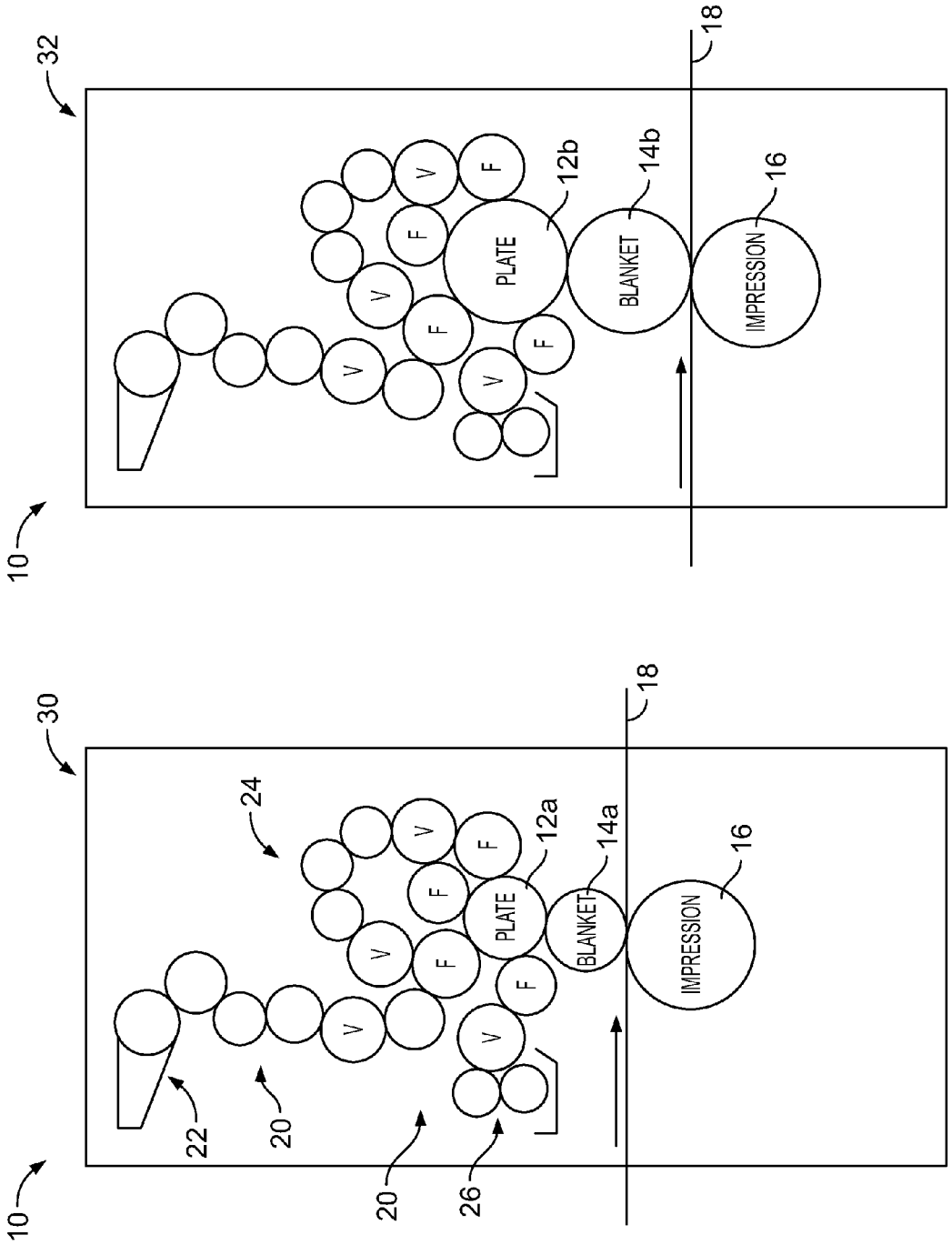
32
18
10
V
F
12b
PLATE
14b
BLANKET
16
IMPRESSION
30
24
12a
14a
22
20
26

FIG. 1

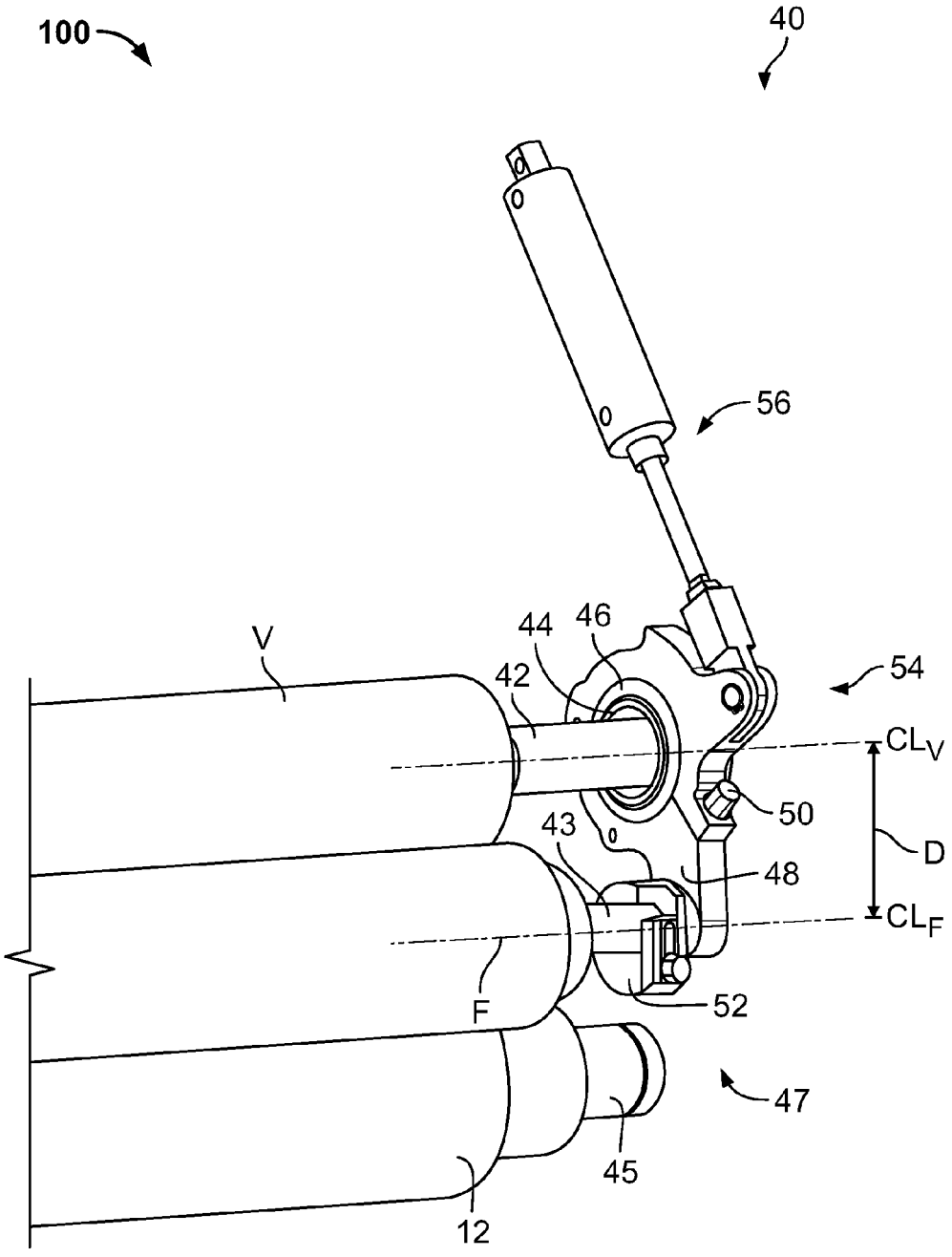

FIG. 2

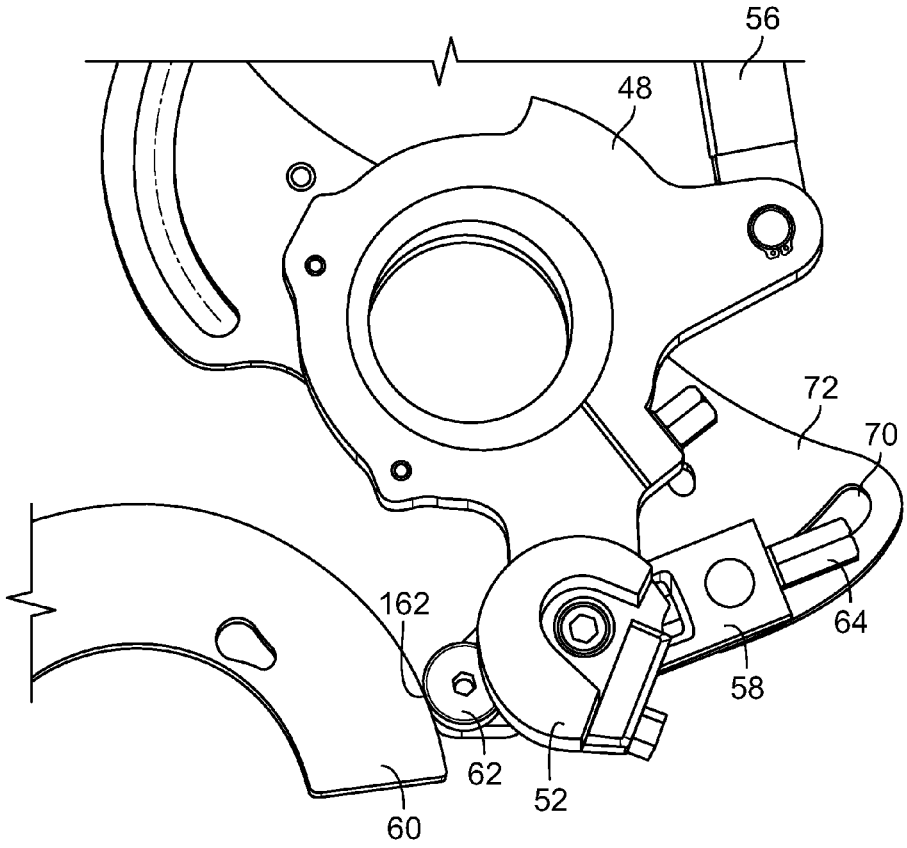

FIG. 3

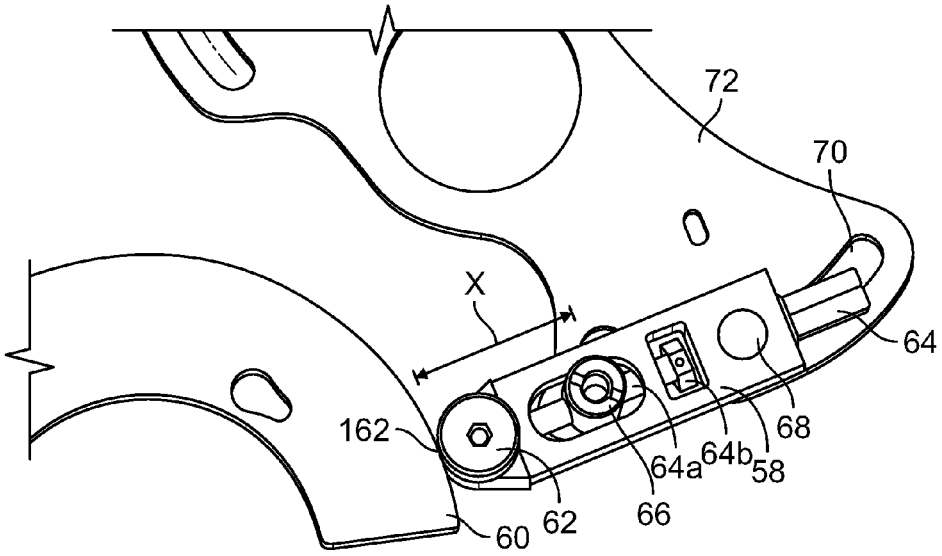

FIG. 4

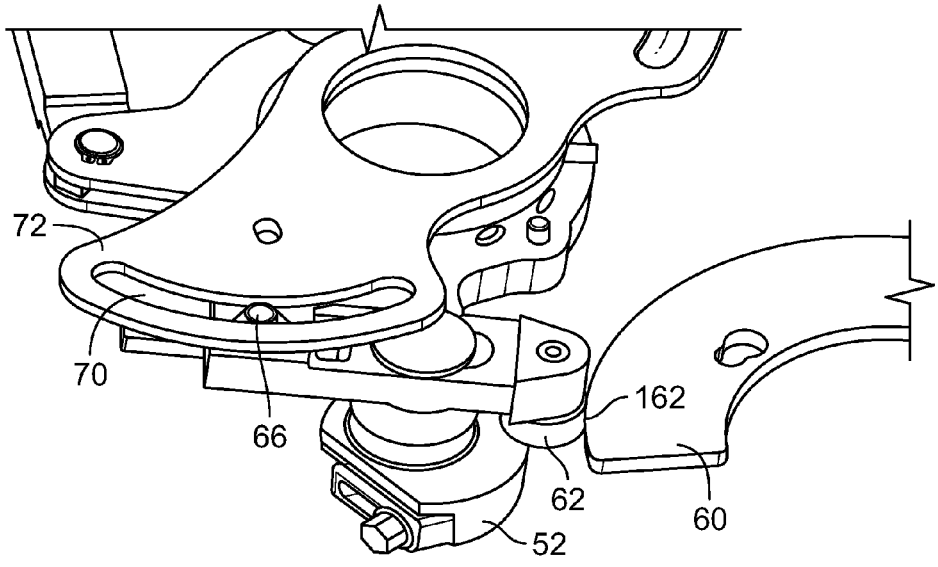

FIG. 5

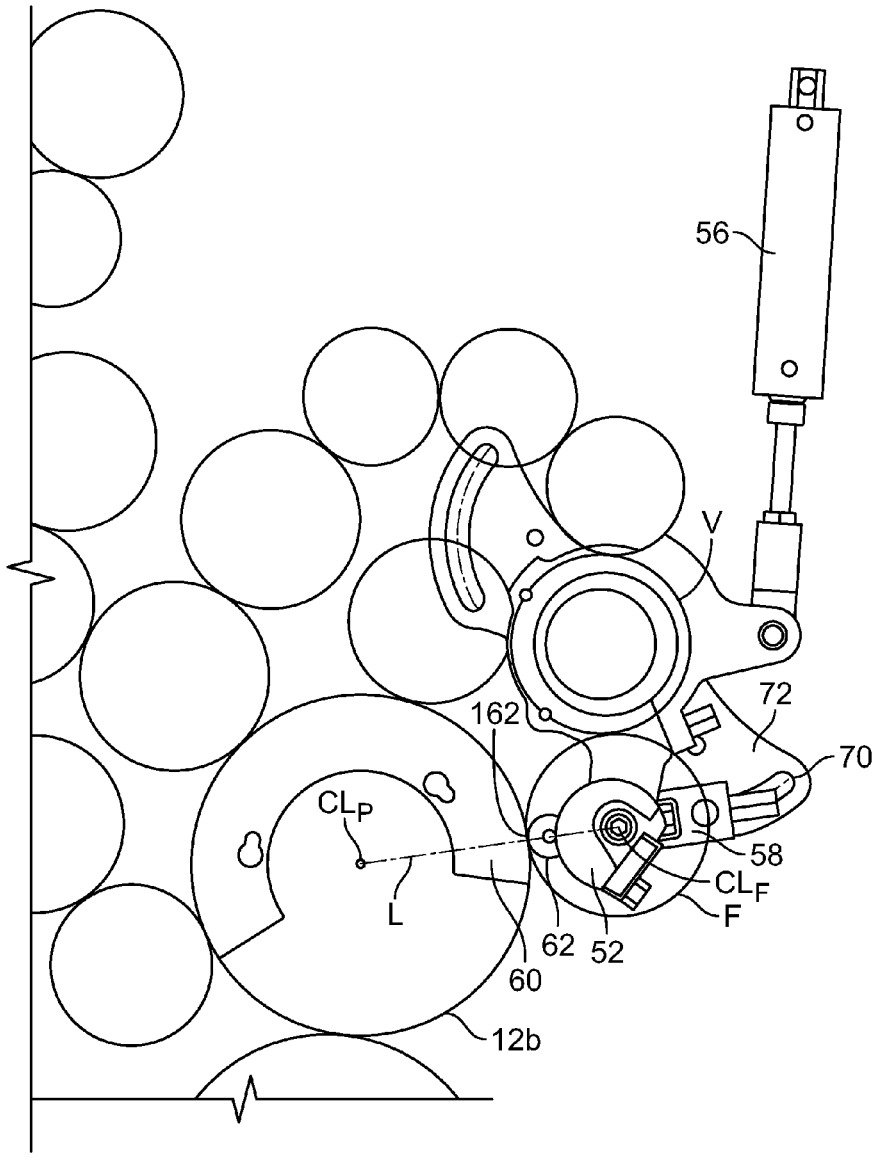

FIG. 6

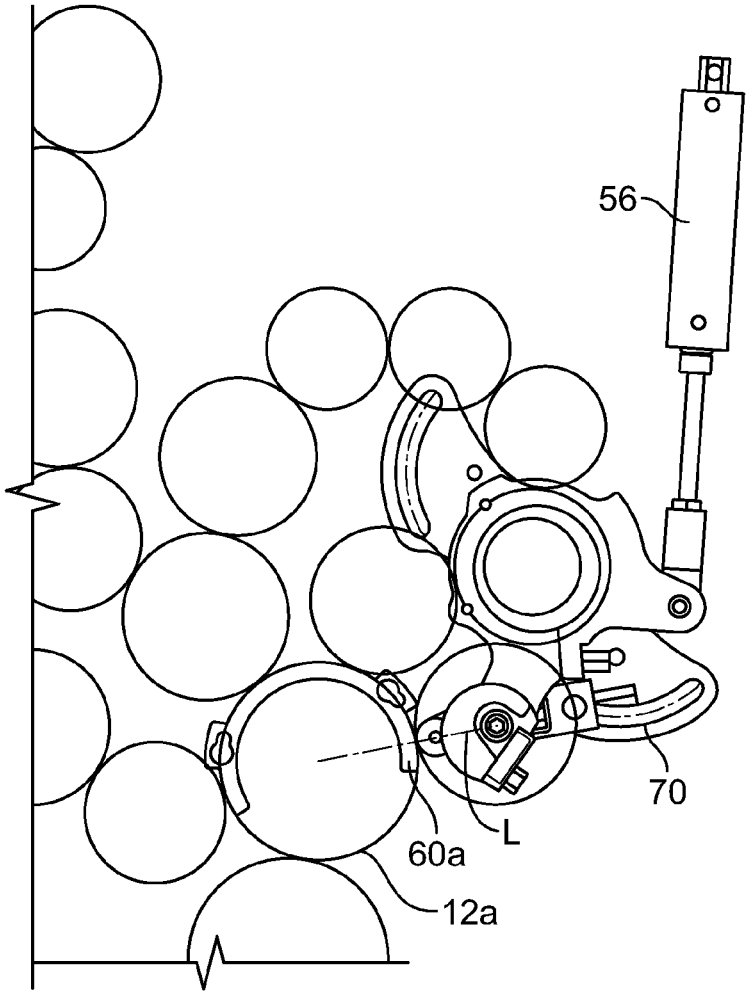

FIG. 7

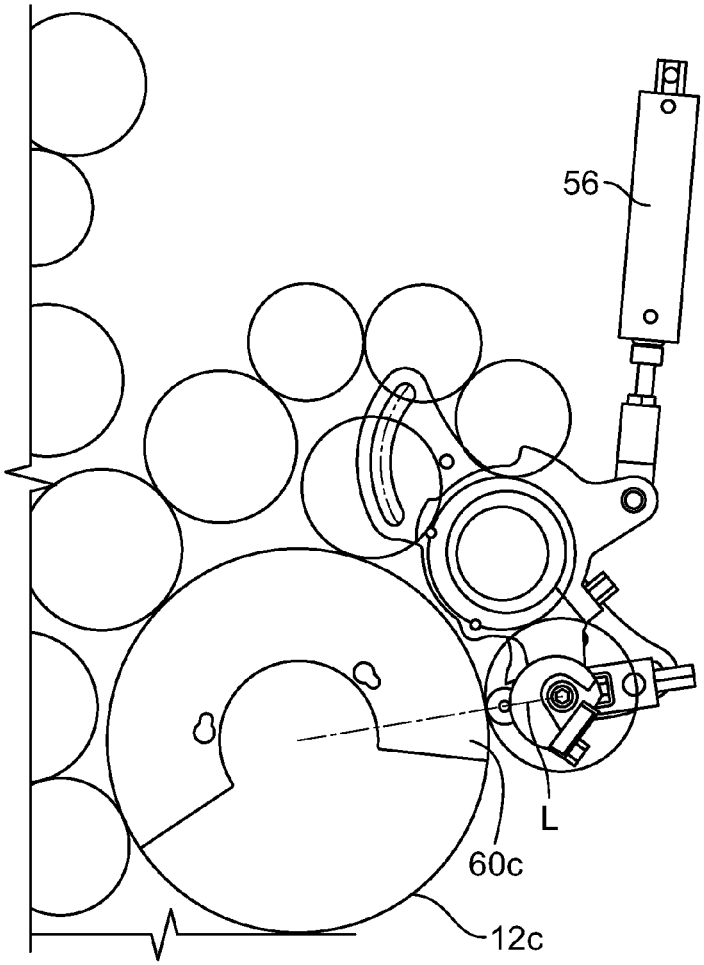

FIG. 8

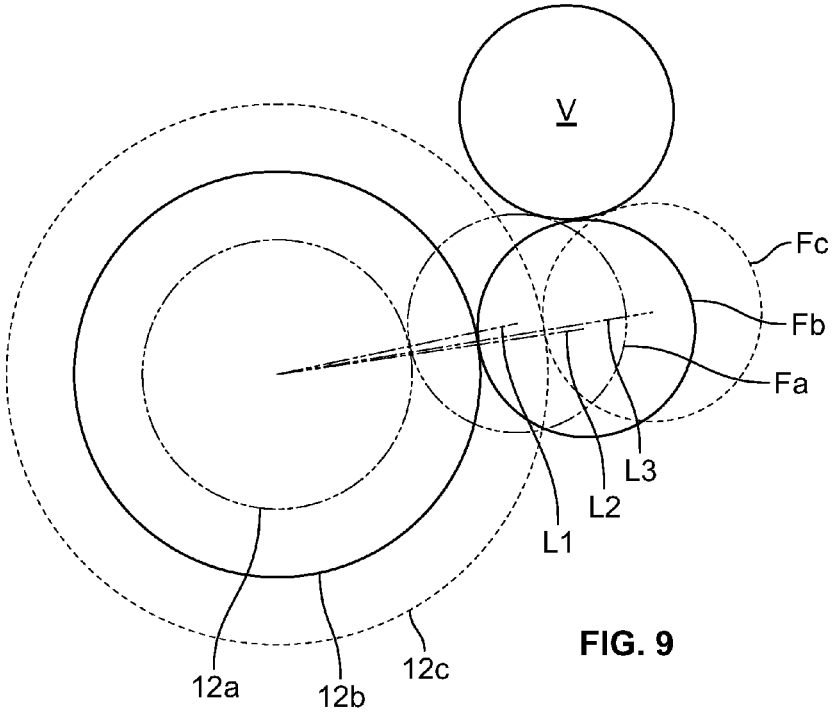
V
Fc
Fb
Fa
L3
L2
L1
12a
12b
12c

FIG. 9

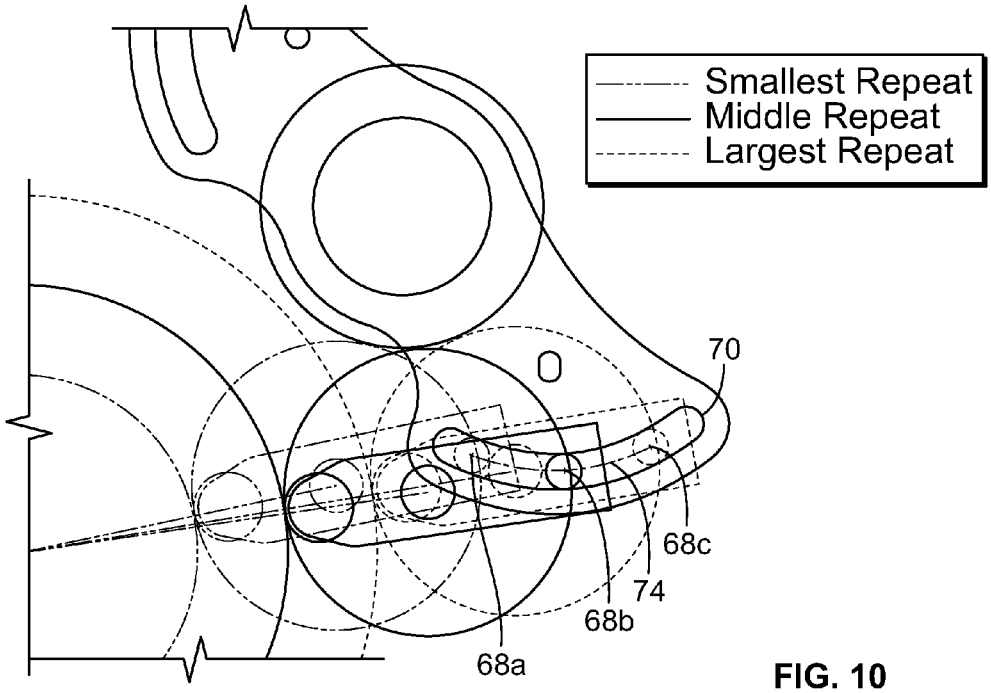
Smallest Repeat
Middle Repeat
Largest Repeat
70
68c
74
68b
68a

FIG. 10

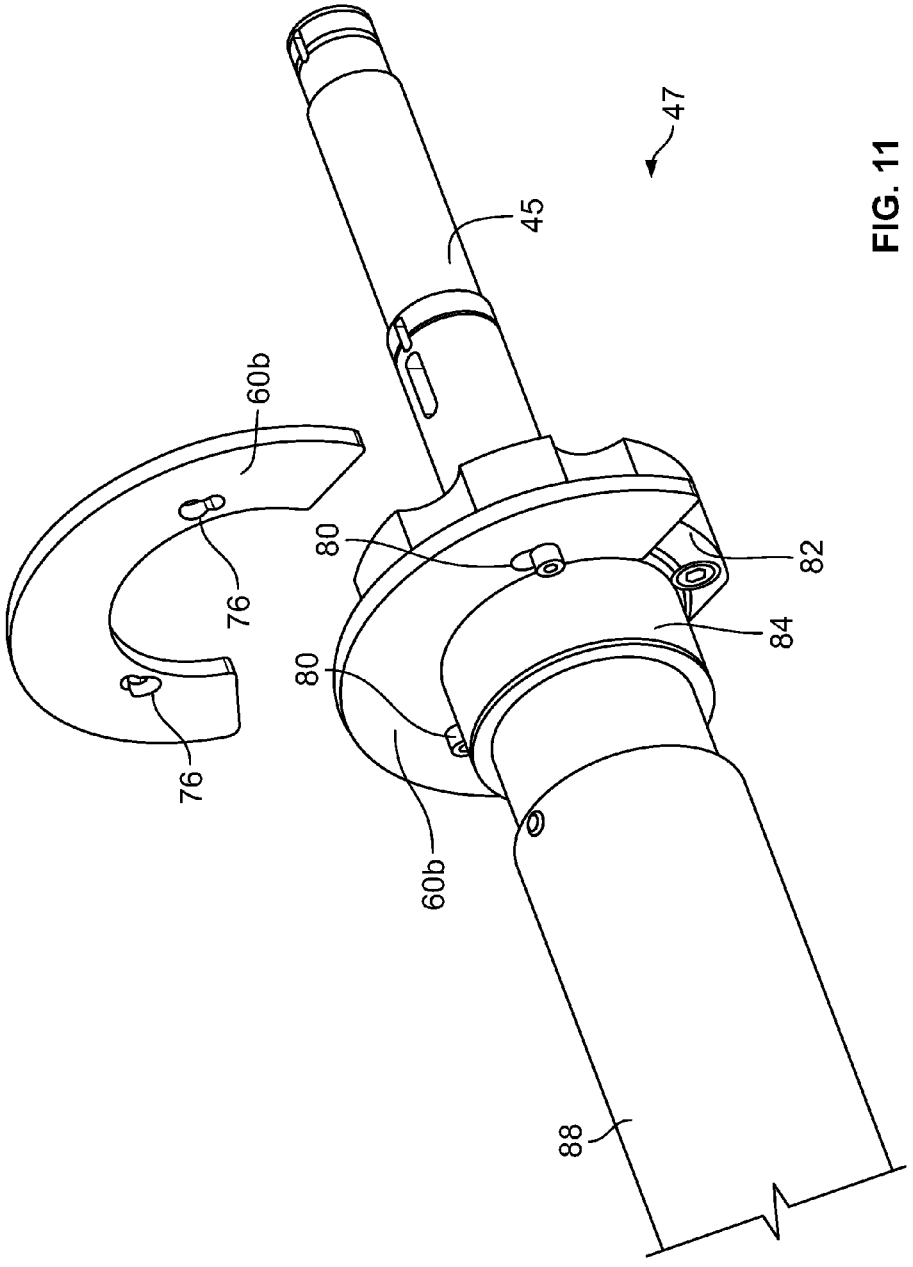

FIG. 11

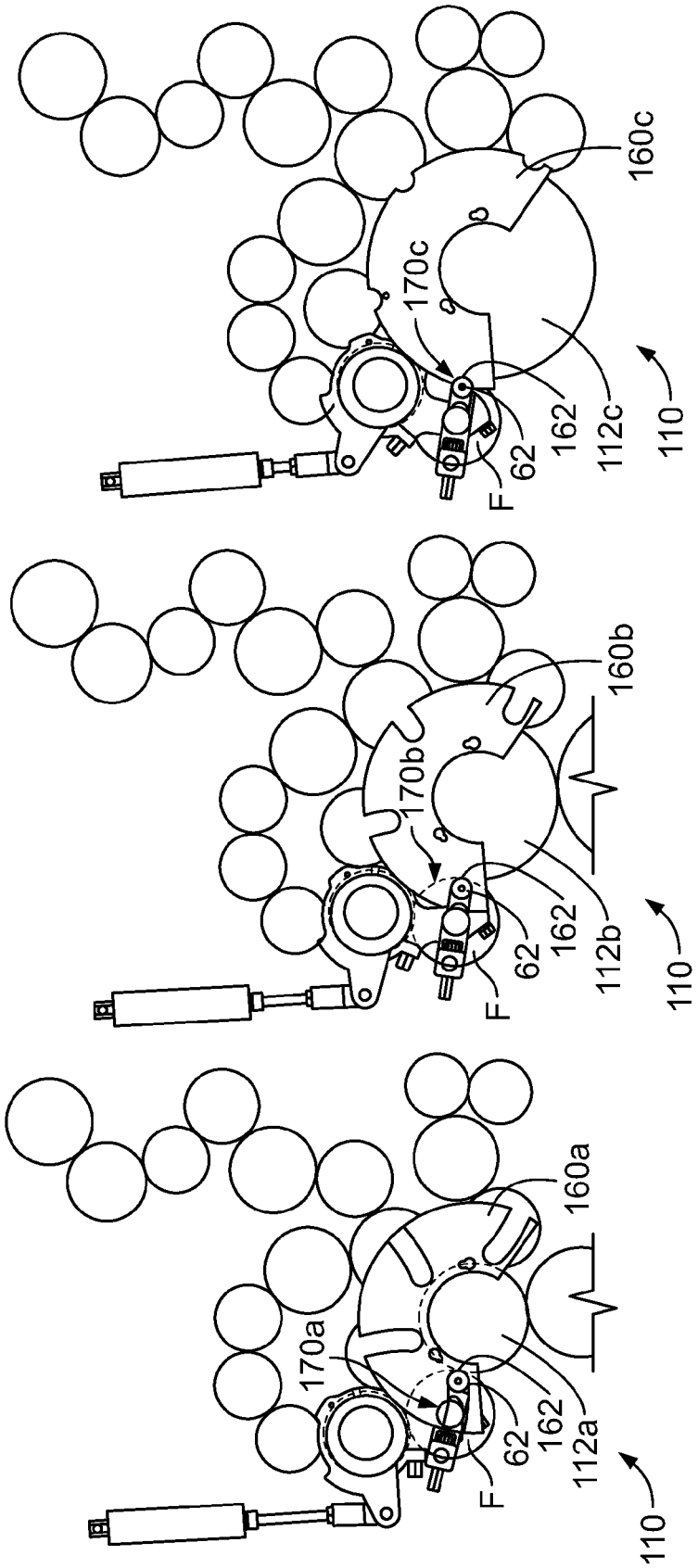
160c
170c
F
62
162
112c
110
160b
170b
F
62
162
112b
110
160a
170a
F
62
162
112a
110

FIG. 12

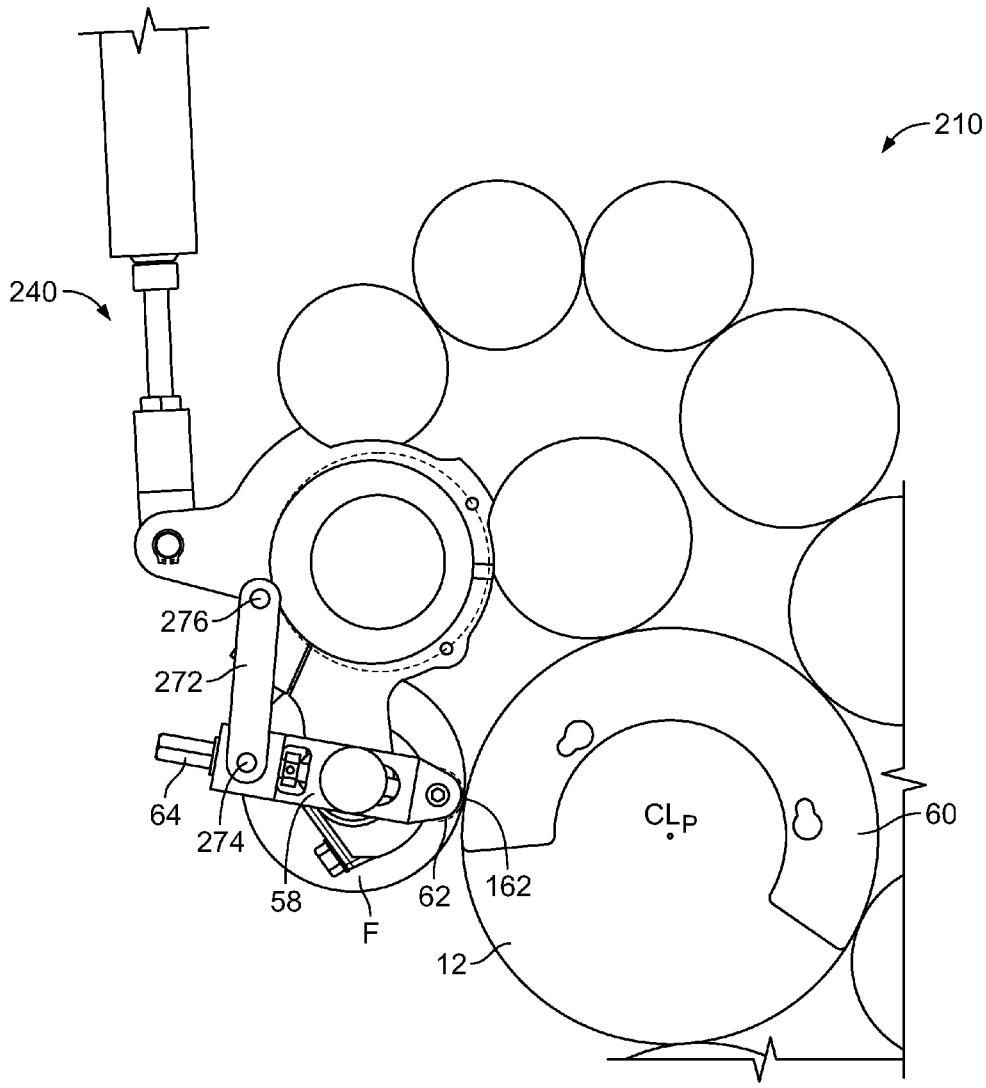

FIG. 13

ADJUSTABLE FORM ROLL APPARATUS

The present invention relates generally to printing presses and more specifically to an adjustable form roll apparatus of a printing press.

BACKGROUND

U.S. Pat. No. 4,458,591 purportedly discloses a printing press having a plate cylinder throw off means including means for disengagement of a plate cylinder from a blanket cylinder without skew movement of the plate cylinder. A form roll-plate cylinder adjustment means is also provided for adjusting the center-to-center distance between the form roll and the plate cylinder. A cam has surface means for maintaining the center-to-center distance between the form roll and the plate cylinder as the plate cylinder is thrown off the blanket cylinder and as the skew adjusting means varies the angle between the blanket and plate cylinders.

U.S. Pat. No. 7,270,057 purportedly discloses an adjustment system for positioning a rolling element such as a form roller or an impression cylinder relative to a first cylinder having a first diameter and relative to at least a second cylinder adapted to replace the first cylinder and having a second diameter different than the first diameter.

Commonly owned U.S. Patent Publication No. 2012/0174807 discloses an adjustable dampening apparatus including a rotatable base for supporting a dampening roller, a rotatable socket connected to the rotatable base for adjusting a position of the dampening roller, a first actuating device connected to the rotatable base for positioning the rotatable base in a predetermined position for a given cutoff and a second actuating device connected to the rotatable socket for positioning the rotatable socket between a first position and a second position.

SUMMARY OF THE INVENTION

An apparatus for adjustably positioning a form roll having a form roll axis against at least two different sized plate cylinders in a variable cutoff printing unit is provided. The apparatus includes a plate cylinder support for interchangeably supporting the at least two different sized plate cylinders, the plate cylinder support including a plate cylinder axis. At least two different sized plate cylinder cams are interchangeably removably connectable to the plate cylinder support and include a smaller plate cylinder cam and a larger plate cylinder cam that are removably connectable to the plate cylinder support as alternatives of each other. The apparatus also includes a form roll hanger for supporting the form roll that is configured for contacting the smaller plate cylinder cam if the smaller plate cylinder cam is coupled to the plate cylinder support to set a smaller distance between the plate cylinder axis and the form roll axis. The form roll hanger is also configured for contacting the larger plate cylinder cam if the larger plate cylinder cam is coupled to the plate cylinder support to set a larger distance between the plate cylinder axis and the form roll axis.

A method of adjustably positioning a form roll having a form roll axis against at least two different sized plate cylinders in a variable cutoff printing unit is also provided. The form roll is supported by a form roll hanger. The method includes placing a first plate cylinder cam of a first cam size and first plate cylinder of a first cylinder size on a plate cylinder support; contacting the first plate cylinder cam with the form roll hanger, the contacting of the first plate cylinder cam with the form roll hanger causing the form roll to enter into a loaded position with the first plate cylinder; removing the first plate cylinder cam and the first plate cylinder from plate cylinder support; placing a second plate cylinder cam of a second cam size and second plate cylinder of a second cylinder size on the plate cylinder support; and contacting the second plate cylinder cam with the form roll hanger, the contacting of the second plate cylinder cam with the form roll hanger causing the form roll to enter into a loaded position with the second plate cylinder.

A variable cutoff printing unit is also provided. The variable cutoff printing unit includes a plate cylinder support including a plate cylinder axis. The plate cylinder support is configured for removably supporting a plate cylinder. The variable cutoff printing unit also includes a plate cylinder cam supported on the plate cylinder support, a form roll for transferring printing fluid to the plate cylinder supported on the plate cylinder assembly; and a form roll hanger supporting an axial end of the form roll and contacting the plate cylinder cam supported on the plate cylinder support to adjustably position the form roll against the plate cylinder supported on the plate cylinder assembly. The form roll hanger includes a surface for contacting the plate cylinder cam. The adjustment assembly is movable along a predefined path to vary a distance between a plate cylinder axis and a form roll axis.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is described below by reference to the following drawings, in which:

FIG. **1** shows a variable cutoff printing unit of a variable cutoff printing press according to an embodiment of the present invention in two different cutoff configurations;

FIG. **2** shows a form roll adjusting apparatus for adjustably positioning a form roll against at least two different sized plate cylinders in the variable cutoff printing unit;

FIG. **3** shows a more detailed view of a form roll hanger of the form roll adjusting apparatus;

FIGS. **4** and **5** show views of further details of the form roll hanger;

FIGS. **6**, **7** and **8** show plan views of the interaction between the form roll hanger, a form roll, a vibrator roll V and three different sized plate cylinders;

FIG. **9** shows the positioning of the form roll according to the three examples of different sized of plate cylinders;

FIG. **10** shows an embodiment of a guide slot setting a predefined path of the for the form roller hanger;

FIG. **11** shows an embodiment of how a plate cylinder support may interchangeably support at least two plate cylinder cams;

FIG. **12** shows three views of a printing unit according to another embodiment of the present invention for three different sized plate cylinder cams; and

FIG. **13** shows three views of a printing unit according to another embodiment of the present invention for three different sized plate cylinder cams.

DETAILED DESCRIPTION

A plate cylinder of a variable cutoff printing press typically varies from 1× to 2× in size during a cutoff change. It is advantageous if form rolls of the printing press are able to accommodate this large of a change in plate cylinder diameter without the need to be reset. Embodiments of the present invention advantageously accommodate such changes by using replaceable cams on a plate cylinder support and an articulated adjustable form roller hanger, allowing the form rolls to be quickly and easily adapted to a new size while

maintaining proper distance between the form rolls and the plate cylinder for good ink transfer. In these embodiments, a centerline of the plate cylinder does not change position during the size change. Embodiments of the invention may also be used for easily adapting a printing press that does move the centerline of the plate cylinder, by retrofitting the printing press so that the centerline of the plate cylinder does not change. Similarly, in preferred embodiments of the present invention, the plate cylinder does not throw-off from a corresponding blanket cylinder when going off impression.

FIG. **1** shows two different repeat sizes or cutoff lengths in a variable cutoff printing unit **10** of a variable cutoff printing press, which may include a plurality of variable cutoff printing units **10** according to an embodiment of the present invention. Variable cutoff printing presses are able to print a plurality of print jobs having a variety of cutoff lengths. In order to accommodate a variety of cutoff lengths, circumferences of plate and blanket cylinders may be varied, for example, blanket and plate cylinders of different sizes may be employed, existing cylinders may be packed or padded to increase their circumference, differently sized sleeves on a fixed size mandrel may be used, or printing plates and blankets having a variety of thicknesses may be interchanged. Printing unit **10** is a non-perfecting printing unit and includes a plate cylinder **12***a* or **12***b*, a blanket cylinder **14***a* or **14***b* and an impression cylinder **16**, cooperating to print on one side of a web **18** passing between impression cylinder **16** and blanket cylinder **14***a* or **14***b*. In other embodiments, printing unit **10** may be a perfecting printing unit, with a second plate cylinder and a second blanket cylinder in place of impression cylinder **16** and printing unit **10** printing on both sides of web **18**. Printing unit **10** further includes an inker and dampener unit **20**, including an ink fountain **22**, a plurality of ink rolls **24** transferring ink from ink fountain **22** to plate cylinder **12** and dampener rolls **26** transferring dampening solution to plate cylinder **12**. Ink rolls **24** and dampener rolls **26** includes vibrator rolls V, which are fixed in a frame of printing unit **10** such that vibrator rolls V are not repositioned during cutoff changes but oscillate axially during printing, and form rolls F, which are circumferentially movable during cutoff changes to maintain proper contact for every size of plate cylinder **12**.

In this embodiment, a plate cylinder center axis CL_P remains fixed as a printing unit **10** is changed from a first cutoff length configuration **30**, as shown on the left in FIG. **1**, to a second cutoff length configuration **32**, as shown on the right in FIG. **1**, and vice versa. In the first configuration **30**, cylinders **12***a* and **14***a*, **16** have an outer circumference of for example sixteen inches and in the second configuration **32**, cylinders **12***b* and **14***b* have an outer circumference of for example twenty-four inches. As is apparent from FIG. **1**, in order for plate cylinder **12***a* to be changed from the first configuration **30** to plate cylinder **12***b* in the second configuration **32**, form rolls F are moved radially away from plate cylinder center axis CL_P of plate cylinder **12**. In order for plate cylinder **12***b* to be changed from the second configuration **32** to plate cylinder **12***a* in the first configuration **30**, form rolls F are moved radially toward plate cylinder center axis CL_P.

FIG. **2** shows a form roll adjusting apparatus **100** for adjustably positioning a form roll F against at least two different sized plate cylinders in a variable cutoff printing unit according to an embodiment of the present invention. Adjusting apparatus **100** includes a form roll hanger **40**, which includes a hanger lever assembly **54** and an actuator **56**, a plate cylinder support **47** and at least two different sized plate cylinder cams **60**, **60***b*, **60***c* (FIGS. **6** to **8**) that are interchangeably removably connectable to plate cylinder support **47**. Lever assembly **54**, in this embodiment, includes form roll F, vibrator roll V, an eccentric **46**, a form roll lever **48**, a bolt **50** and a roll holder **52**. A shaft **42** of vibrator roll V is surrounded by a vibrator bushing **44** and eccentric **46**, which surrounds vibrator bushing **44**. Eccentric **46** is mounted inside of a form roll lever **48** and rotatable within form roll lever **48** to set a distance D between a center axis CL_V of vibrator roll V and a center axis CL_F of form roll F. Once distance D is adjusted to the desired amount, a bolt **50** inserted into a hole in form roll lever **48** is tightened to secure eccentric **46** in place to set distance D. The clamping of bolt **50** allows form roll F to be rotated about vibrator bushing **44** while maintaining distance D. Roll holder **52** is connected to form roll lever **48** and rotatably mounts a form roll F, via a shaft **43**, on form roll lever **48**. The mounting of roll holder **52** in form roll lever **48** allows roll holder **52** to rotate without affecting the setting between form roll F and vibrator roll V. Actuator **56**, which in a preferred embodiment is a pneumatic actuator, but may in other embodiments may be for example a hydraulic, mechanical or electromechanical actuator, is tangentially connected to an outer edge of form roll lever **48** and acts to rotate lever assembly **54** around vibrator bushing **44** towards or away from plate cylinder **12** and a plate cylinder shaft **45**.

FIG. **3** shows a more detailed view of form roll hanger **40** with form roll F and vibrator roll V omitted for clarity. As shown in FIG. **3**, an adjustment assembly **58** is coupled to roll holder **52** and form roll lever **48** on a side of hanger **40** opposite roll holder **52**. Adjustment assembly **58** is rotatably mounted at a pivot pin **66** (FIG. **4**) on form roll lever **48**. In this embodiment, pivot pin **66** of adjustment assembly **58** is coincident with center axis CL_F of form roll F (FIG. **2**). A plate cylinder cam **60** is coupled to plate cylinder shaft **45** (FIG. **2**) for guiding a cam follower **62** on an end of adjustment assembly **58**. Adjustment assembly **58** includes a contact surface **162** on cam follower **62** for contacting plate cylinder cam **60**. In order to vary the distance between center axis CL_F of form roll F and center axis CL_P of plate cylinder **12** (FIG. **1**), cam follower **62** may be adjusted by an adjustor **64** of adjustment assembly **58**. In this embodiment, adjustor **64** is a screw. Actuator **56** provides the force to maintain contact between contact surface **162** and plate cylinder cam **60**.

FIGS. **4** and **5** show views of further details of form roll hanger **40**, with certain features omitted for clarity. Adjustor **64** includes a threaded portion **64***a* and a shoulder **64***b*. Threaded portion **64***a* is threaded into a threaded hole in adjustment assembly **58** into a threaded hole in pivot pin **66** such that rotation of adjustor **64** changes a distance X between a center of pivot pin **66** and contacting surface **162** of cam follower **62**. Pivot pin **66** is mounted in and free to rotate in form roll lever **48** (FIGS. **2** and **3**). Adjustment assembly **58** further includes a guide portion **68**, which in this embodiment is in the form of a pin, extending into a slot **70** in a guide **72**, e.g., a cam, fixed to the frame of printing unit **10** (FIG. **1**). In this embodiment, cam follower **62** is rotatably mounted on adjustment assembly **58**. In alternative embodiments, in place of rotatably mounted cam follower **62**, a non-rotatable surface may be used for contacting plate cylinder cam **60**. For example, the non-rotatable surface may be flat, concave or convex and function adequately. Of the components shown in FIG. **5**, guide **72** is the furthest outward in the axial direction with respect to an axial center of the printing unit, followed by adjustment assembly **58**, then form roll lever **48** and form roll holder **52**.

FIG. **6** shows a plan view of the interaction between form roll hanger **40**, form roll F, vibrator roll V and middle size plate cylinder **12***b*. In this embodiment, an outer circumference of a middle plate cylinder cam **60***b* is concentric with and

the same or similar to an outer circumference of plate cylinder **12***b*. Similarly FIG. **7** shows an effective outer diameter of plate cylinder cam **60***a* is the same or similar to an outer diameter of plate cylinder **12***a*. Plate cylinder cam **60***a* is preferably mounted with respect to plate cylinder **12***a* (and plate cylinder support **47** shown in FIG. **11**) such that if the plate cylinder center axis CL_P moves, plate cylinder cam **60***a* remains concentric with plate cylinder center axis CL_P. Accordingly, in this embodiment, if plate cylinder **12***a* is removed and replaced with a plate cylinder having a larger diameter, e.g., larger plate cylinder **12***c* shown in FIG. **8**, larger plate cylinder **12***c* includes a larger plate cylinder cam **60***c* that has the same effective outer diameter as the outer diameter of larger plate cylinder **12***c* and is concentric with plate cylinder center axis CL_P. Center axis CL_P may change for plate skewing or throw-off.

In FIG. **6**, cam **60** is shown for a middle size repeat for variable cutoff printing unit **10**. Cam follower **62** is set by adjustment assembly **58** so that when loaded by actuator **56**, a proper squeeze between form roll F and plate cylinder **12***b* is attained. A center of cam follower **62** is located on a line L between plate cylinder center axis CL_P and center axis CL_F of form roll F. This alignment is accomplished by guide portion **68** being positioned in slot **70** of guide **72**.

FIGS. **7** and **8** show plan views of plate cylinder cams **60***a*, **60***c* for two cutoff lengths, smaller and larger than plate cylinder **12***b*, respectively. For example as discussed above plate cylinder **12***a* has a cutoff length of sixteen inches and for example plate cylinder **12***c* has a cutoff length of thirty-two inches. Plate cylinder cams **60***a*, **60***c* are unique to each size of plate cylinders **12***a*, **12***c*, respectively, and in this embodiment have effective outer diameters equal to the outer diameters of corresponding plate cylinders **12***a*, **12***c*. Slot **70** is formed in guide **72** such that guide **72** defines a predefined path for form roll hanger **40** and slot **70** of guide **72**, through interaction with guide portion **68** of form roll hanger **40**, maintains the position of contact surface **162** of cam follower **62** on centerline L. The predefined path allows form roll F to maintain appropriate contact with vibrator roll V and a plurality of sized plate cylinders. In alternative embodiments, form roller F may be sized slightly different such that contact surface **162** of cam follower **62** is not exactly maintained on centerline L and still functions properly. In another embodiment, the cams can be larger or smaller than an outer circumference of plate cylinder as long as the offset is similar.

FIG. **9** shows the positioning of form roll F according to three different sizes of plate cylinders. First, with respect to plate cylinder **12***a* of smallest diameter, form roll F is rotated into a position Fa the furthest clockwise with respect to vibrator roll V. Next, with respect to plate cylinder **12***b* of a middle diameter, form roll F is positioned into a position Fb further counterclockwise with respect to vibrator roll V. Lastly, with respect to a plate cylinder **12***c* of largest diameter, form roll F is positioned into a position Fc further counterclockwise with respect to vibrator roll V. As form roll F is repositioned for each plate cylinder **12***a*, **12***b*, **12***c* lines L**1**, L**2**, L**3** between plate cylinder center axis CL_P and form roll center axis CL_F also move.

FIG. **10** shows the configuration and shape of the curve of guide slot **70** according to one embodiment of the present invention. In this example, an arc **74** includes three positions **68***a*, **68***b*, **68***c* for guide portion **68** for the three different sized plate cylinders **12***a*, **12***b*, **12***c* shown in FIG. **9** (and their respective cams **60***a*, **60***b*, **60***c*) that defines the shape of guide slot **70** and establishes the predefined path of hanger **40**. Position **68***a* of the predefined path for guide portion **68** corresponds to small plate cylinder **12***a*, position **68***b* of the predefined path for guide portion **68** corresponds to the middle plate cylinder **12***b* and position **68***c* of the predefined path for guide portion **68** corresponds to the large plate cylinder **12***c*. The shape of guide slot **70** may also be accurately determined to establish the predefined path of hanger **40** by fitting a polynomial or similar mathematical curve through more than three positions.

FIG. **11** shows how plate cylinder support **47** may interchangeably support at least two plate cylinder cams, e.g. plate cylinder cams **60***a*, **60***b*, **60***c*. In this embodiment, plate cylinder support **47** includes shaft **45**, a mandrel **88** for receiving plate cylinders of varying sizes in sleeve form and a plate cylinder bearing housing **82** connecting mandrel **88** and shaft **45**. As similarly discussed above, plate cylinder cams **60***a*, **60***b*, **60***c* are removably connectable to plate cylinder support **47** as alternatives of each other. In other words, only one of plate cylinder cams **60***a*, **60***b*, **60***c* is connected to plate cylinder support **47** depending on the desired cutoff of the variable cutoff printing unit. For example, for a print job requiring smaller plate cylinder **12***a*, plate cylinder cam **60***a* is removably secured to plate cylinder support **47**, for a print job requiring middle plate cylinder **12***b*, plate cylinder cam **60***b* is removably secured to plate cylinder support **47** and for a print job requiring a print job requiring larger plate cylinder **12***c*, plate cylinder cam **60***c* is removably secured to plate cylinder support **47**. Thus, to change from smaller plate cylinder **12***a* to large plate cylinder **12***c*, plate cylinder cam **60***a* interchanged with plate cylinder cam **60***c* by disconnecting and removing plate cylinder cam **60***a* from plate cylinder support **47** and mounting on plate cylinder cam **60***c* on plate cylinder support **47** and connecting plate cylinder cam **60***c* to plate cylinder support **47**. As shown in FIG. **11**, for example, plate cylinder cam **60***b* may be interchangeably removably connected to plate cylinder support **47** according to one embodiment of the present invention. Plate cylinder cam **60***b*, which is shown in FIG. **11** both before and after plate cylinder cam **60***b* is mounted on plate cylinder support **47**, includes keyhole slots **76** formed therein for interaction with correspondingly configured connectors **80** on plate cylinder bearing housing **82** coupled to plate cylinder shaft **45**. A radial edge of plate cylinder cam **60***b* axially abuts a radially protruding portion of plate cylinder bearing housing **82** and an inner circumference of plate cylinder cam **60***b* is flush with a pilot portion **84** of plate cylinder bearing housing **82**. In this embodiment, an effective outer diameter and outer circumference of each plate cylinder cam **60***a*, **60***b*, **60***c* corresponds to the outer diameter and outer circumference of the respective plate cylinder **12***a*, **12***b*, **12***c* and an inner circumference and an inner diameter of each plate cylinder cam **60***a*, **60***b*, **60***c* corresponds to an outer diameter and outer circumference of pilot portion **84**. In other embodiments, plate cylinder cams may be supported on plate cylinder shaft **45** in a manner that a surface supporting plate cylinder cams does not rotate.

The embodiment described above with respect to FIGS. **1** to **11** allows form roll F to be positioned against at least two different sized plate cylinders in the variable cutoff printing presses. Although only three different sized plate cylinders **12***a*, **12***b*, **12***c* and corresponding plate cylinder cams **60***a*, **60***b*, **60***c* are described above for use with printing unit **10**, any number of different sized plate cylinders and corresponding plate cylinder cams may be used in printing unit **10**, with plate cylinder support **47** being configured for interchangeably removably supporting the different sized plate cylinders and corresponding plate cylinder cams as alternatives of each other. For example, form roll adjusting apparatus **100** may adjustably position form roll F against two different sized plate cylinders to print two different print jobs of two different

cutoffs one after another. For the first print job of the first cutoff, a first sized plate cylinder, e.g., plate cylinder **12***b*, having a first diameter, and a first sized plate cylinder cam, e.g., plate cylinder cam **60***b*, having a first effective diameter equal to the first diameter, are placed on plate cylinder support **47**. As discussed above, plate cylinder cam **60***b* is placed on plate cylinder support **47** by bringing the inner circumference of plate cylinder cam **60***b* into contact with pilot portion **84** of plate cylinder bearing housing **82** and removably connecting plate cylinder cam **60***b* to plate cylinder support **47** by engaging holes keyhole slots **76** in plate cylinder cam **60***b* with connectors **80** on plate cylinder bearing housing **82**. Actuator **56** may then move hanger **40** along the predefined path defined by guide **72** such that guide portion **68** of hanger **40** enters into position **68***b* of the predefined path in slot **70** and hanger **40**, via contact surface **162** of cam follower **62**, contacts plate cylinder cam **60***b*, causing form roll F to enter into a loaded position with plate cylinder **12***b*. In the loaded position, form roll F is either in contact with plate cylinder **12***b* or is spaced away from plate cylinder **12***b* such a small distance that adjustment by adjustor **64** bring form roll F into contact with plate cylinder **12***b*. Adjustment assembly **58** may be adjusted before or after form roll F is loaded onto plate cylinder **12***b* by moving adjustor **64** to vary the position of cam follower **62** and set the squeeze between form roll F and plate cylinder **12***b* at a desired amount. The first print job of the first cutoff length may then be printed by printing unit **10**.

After the first print job is printed, actuator **56** may move hanger **40** along guide **72** such that form roll F is moved away from plate cylinder **12***b* and contact surface **162** is moved away from plate cylinder cam **60***b* so that plate cylinder cam **60***b* and plate cylinder **12***b* may be interchanged with another plate cylinder cam, e.g., plate cylinder cam **60***a* or **60***c*, and another plate cylinder, e.g., plate cylinder **12***a* or **12***c*. Then, plate cylinder cam **60***b* may be removed from plate cylinder support **57** by disengaging slots **76** from connectors **80** and sliding plate cylinder cam **60***b* off of pilot portion **84** and plate cylinder **12***b* may be removed from plate cylinder support **47**. For the second print job of the second cutoff, a second sized plate cylinder, e.g., plate cylinder **12***a* or **12***c*, having a second diameter different from the first diameter, and a second sized plate cylinder cam, e.g., plate cylinder cam **60***a* or **60***c*, having a second effective diameter equal to the second diameter, are placed on plate cylinder support **47**. As similar to plate cylinder cam **60***b* discussed above, plate cylinder cam **60***a* or **60***c* is placed on plate cylinder support **47** by bringing the inner circumference of plate cylinder cam **60***a* or **60***c* into contact with pilot portion **84** of plate cylinder bearing housing **82** and removably connecting plate cylinder cam **60***a* or **60***c* to plate cylinder support **47** by engaging holes keyhole slots **76** in plate cylinder cam **60***a* or **60***c* with connectors **80** on plate cylinder bearing housing **82**. Actuator **56** may then move hanger **40** along the predefined path defined by guide **72** such that guide portion **68** of hanger **40** enters into either position **68***a* or **68***c* of the predefined path in slot **70** and hanger **40**, via contact surface **162** of cam follower **62**, contacts plate cylinder cam **60***b*, causing form roll F to enter into a loaded position with plate cylinder **12***b*. In the loaded position, form roll F is in contact with plate cylinder **12***a* or **12***c*. The second print job of the second cutoff length may then be printed by printing unit **10**.

In the example described above, form roll hanger **40** is configured for contacting at least the three exemplary different sized plate cylinder cams **60***a*, **60***b*, **60***c* to set different distances between plate cylinder axis CL_P and form roll axis CL_F. If the smaller plate cylinder cam **60***a* is coupled to the plate cylinder support **47**, form roll hanger **40** sets a smaller distance between plate cylinder axis CL_P and form roll axis CL_F. If the larger plate cylinder cam **60***c* is coupled to the plate cylinder support **47**, form roll hanger **40** sets a larger distance between plate cylinder axis CL_P and form roll axis CL_F. If the middle plate cylinder cam **60***b* is coupled to the plate cylinder support **47**, form roll hanger **40** sets a middle distance, i.e., a distance larger than the smaller distance and smaller than the larger distance, between plate cylinder axis CL_P and form roll axis CL_F. As a result, form roll hanger **40** allows printing unit **10** to be used to print using at least the three exemplary different sized plate cylinders **12***a*, **12***b*, **12***c* to print the at least three different exemplary cutoff lengths.

FIG. **12** shows three views of a printing unit **110** according to another embodiment of the present invention, each showing printing unit **110** configured for a different sized plate cylinder cam **160***a*, **160***b*, **160***c*. As is shown, guide **72** (FIGS. **4** to **8**) has been omitted and plate cylinder cams **160***a*, **160***b*, **160***c* themselves include guides in the form of guide slots **170***a*, **170***b*, **170***c*, respectively, for receiving cam followers **62**. In this embodiment, guides **170***a*, **170***b*, **170***c* are configured to define the predefined path of form roll hanger **240** that allows form roll F to maintain appropriate contact with vibrator roll V and the corresponding plate cylinder. Other than this difference, form roll hanger **140** may be formed in the same manner as form roll hanger **40** shown in FIGS. **2** to **11**. In contrast to plate cylinder cams **60***a*, **60***b*, **60***c* shown in FIGS. **6** to **8**, outer diameters of cams **160***a*, **160***b*, **160***c* are greater than the outer diameters of corresponding plate cylinders **112***a*, **112***b*, **112***c*, respectively. However, guide slots **170***a*, **170***b*, **170***c* are configured to guide and stop the movement of cam followers **62** along the outer diameter of plate cylinders, respectively, such that a proper squeeze between form roll F and plate cylinders **112***a*, **112***b*, **112***c* is attained. As shown in FIG. **12**, each of cams **160***a*, **160***b*, **160***c* may include a plurality of respective guide slots **170***a*, **170***b*, **170***c*, which can be used with respective other form roll hanger assemblies **140** to position additional form rolls F.

FIG. **13** shows a printing unit **210** according to another embodiment of the present invention including a form roll hanger **240**. As is shown, guide **72** (FIGS. **4** to **8**) has been replaced with a guide **272**, e.g., a link, that is rotatably connected to adjustment assembly **58** by a first pivot **274** and is rotatably fixed to a frame of printing unit **210** by a second pivot **276**. In this embodiment, guide **272** is configured to define the predefined path of form roll hanger **240** that allows form roll F to maintain appropriate contact with vibrator roll V and a plurality of sized plate cylinders. Other than this difference, form roll hanger **240** may be formed in the same manner as form roll hanger **40** shown in FIGS. **2** to **11**. Adjustment assembly **58** is adjustable by using adjustor **64** to move cam follower **62** toward and away from center axis CL_P of plate cylinder **12** to contact plate cylinder cam **60** and set a proper squeeze between form roll F and plate cylinder **12**.

In the preceding specification, the invention has been described with reference to specific exemplary embodiments and examples thereof. It will, however, be evident that various modifications and changes may be made thereto without departing from the broader spirit and scope of invention as set forth in the claims that follow. The specification and drawings are accordingly to be regarded in an illustrative manner rather than a restrictive sense.

What is claimed is:

1. An apparatus for adjustably positioning a form roll against at least two different sized plate cylinders in a variable cutoff printing unit, the form roll having a form roll axis, the apparatus comprising:

a plate cylinder support for interchangeably supporting the at least two different sized plate cylinders, the plate cylinder support including a plate cylinder bearing housing and a plate cylinder axis, the plate cylinder axis defining a centerline of the plate cylinder, wherein the centerline does not change position, except that the centerline may change position for plate skew or throw-off;

said plate cylinder bearing housing capable of interchangeably supporting at least two different sized plate cylinder cams, the at least two different sized plate cylinder cams including a smaller plate cylinder cam and a larger plate cylinder cam that are removably connectable to the plate cylinder support as alternatives of each other; and

a form roll hanger for supporting the form roll, the form roll hanger being configured for contacting the smaller plate cylinder cam if the smaller plate cylinder cam is coupled to the plate cylinder support to set a smaller distance between the plate cylinder axis and the form roll axis, the form roll hanger being configured for contacting the larger plate cylinder cam if the larger plate cylinder cam is coupled to the plate cylinder support to set a larger distance between the plate cylinder axis and the form roll axis.

2. The apparatus as recited in claim **1** wherein the form roll hanger includes a contact surface for contacting the one of the at least two different sized plate cylinder cams that is supported on the plate cylinder support, the form roll hanger being movable along a predefined path to vary a distance between the plate cylinder axis and the form roll axis.

3. The apparatus as recited in claim **2** further comprising a guide defining the predefined path, the guide controlling movement of the form roll hanger as the contact surface is moved toward and away from the plate cylinder axis.

4. The apparatus as recited in claim **3** wherein the guide is configured such that the predefined path followed by the form roll hanger causes the form roll hanger to be slideable into positions for the contact surface to contact each of the at least two different sized plate cylinder cams as the at least two different sized plate cylinder cams are alternately connected to the plate cylinder support.

5. The apparatus as recited in claim **1** further comprising a vibrator roll, the form roll hanger including a bearing for rotatably supporting the vibrator roll.

6. The apparatus as recited in claim **5** wherein the form roll hanger further includes an eccentric, the eccentric being configured so as to maintain predefined contact pressure between the vibrator roll and the form roll as the form roll axis is moved toward and away from the plate cylinder axis.

7. A variable cutoff printing unit comprising:

the assembly for adjustably positioning a form roll against at least two different sized plate cylinders as recited in claim **1**;

the at least two different sized plate cylinders, the at least two different sized plate cylinders including a smaller plate cylinder and a larger plate cylinder that are removably connectable to the plate cylinder support as alternatives of each other; and

the form roll, the form roll hanger supporting the form roll;

the form roll hanger being configured such that the smaller plate cylinder contacts the form roll when the smaller plate cylinder and the smaller plate cylinder cam are connected to the plate cylinder support and the smaller plate cylinder cam contacts the form roll hanger, the form roll hanger being configured such that larger plate cylinder contacts the form roll when the larger plate cylinder and the larger plate cylinder cam are connected to the plate cylinder support and the larger plate cylinder cam contacts the form roll hanger.

8. The variable cutoff printing press as recited in claim **7** wherein the form roll hanger includes a contact surface for contacting the one of the at least two different sized plate cylinder cams that is supported on the plate cylinder support, the form roll hanger a predefined path.

9. The variable cutoff printing press as recited in claim **8** wherein the predefined path includes a first position and a second position, the contact surface being at an outer diameter of the smaller plate cylinder cam when a guide portion of the form roll hanger is at the first position, the contact surface being at an outer diameter of the larger plate cylinder cam when the guide portion of the form roll hanger is at the second position.

10. The variable cutoff printing press as recited in claim **9** wherein an outer surface of the form roll is at an outer surface of the smaller plate cylinder when the guide portion of the form roll hanger is at the first position, the outer surface of the form roll being at an outer diameter of the larger plate cylinder when the guide portion of the form roll hanger is at the second position.

11. The variable cutoff printing press as recited in claim **8** wherein the defined path includes a plurality of predefined positions, a contact surface of the form roll hanger being at an outer diameter of one of the at least two different sized plate cylinders when the guide portion of the form roll hanger is at each of the predefined positions.

12. The apparatus as recited in claim **1** further comprising a linear actuator, the linear actuator controlling movement of the form roll hanger as the contact surface is moved toward and away from the plate cylinder axis.

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